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Non-fasting Non-High Density Lipoprotein Cholesterol (Non-HDL-C) AS A predictor of Atherosclerosis in Patients with End Stage Renal Disease on Regular Hemodialysis

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Abstract

Fifty patients with chronic renal failure on regular hemodialysis 31 males and 19 females, aged from 18 to 62 years were included in the study. They were selected from those attending the Nephrology and Dialysis Unit in Damanhour Medical Institute.

Ten age and sex matched subjects with normal renal function served as control group. Full history taking, clinical examination, resting ECG and serum cholesterol, HDL (non-fasting), fasting LDL, non-fasting non-HDL from special equation, Non- HDL = total cholesterol - HDL and Duplex scanning of both carotid and femoral arteries.

Non fasting non-HDL was more than 130 mg/dl in more than 65% of patients group versus 30% in control group, serum level of non-fasting cholesterol and non-fasting non-HDL were significantly elevated in hemodialysis patients as compared with control group, while serum level of non-fasting HDL and fasting LDL were significantly decreased in hemodialysis patients as compared with control group. Intima-Media thickness (IMT) of both carotids and both femoral arteries was elevated in hemodialysis patients as compared with control group. There was a significant positive correlation between non-fasting non-HDL and IMT of both carotids and both femoral arteries and a significant positive correlation between fasting LDL and IMT of both carotids and femoral arteries. There was a significant positive correlation between duration of dialysis and IMT of both carotids and left femoral arteries.

A positive correlation exists between ECG ischemic changes and IMT of both carotids and left femoral arteries and between carotid plaques and IMT of both carotids and left femoral arteries.

Aim of the Work

To study and compare between the level of non-fasting non-HDL-C and fasting LDL in predialysis serum as predictor of atherosclerotic changes in patients with end stage renal disease on regular hemodialysis.

Indroduction

ESRD patients show various abnormalities in plasma lipids and lipoproteins that are called uremic dyslipidemia (Shoji *et al*., 1997).

Atherosclerosis and cardiovascular disturbance are common among patients with progressive renal insufficiency and in uremic patients receiving long-term hemodialysis (Jungers *et al*., 1997).

Cardiovascular disease is the most important cause of mortality in end-stage renal disease (Merzog *et al*., 1999).

Plasma lipid disturbance have been identified as significant risk factor for cardiovascular disease in end-stage renal disease patients (Mittman *et al*., 1996).

The main lipid abnormality is an increase in plasma triglyceride and a decrease in HDL cholesterol concentrations with smaller change in the levels of cholesterol rich lipoproteins (Koniger *et al.*, 1999).

Lipoprotein changes have been shown to be closely associated with atherosclerosis in ESRD patients. Non-HDL cholesterol (cholesterol in VLDL + IDL + LDL fraction) was shown to be an independent factor for both carotid artery intima-media thickness (Shoji *et al.*, 2000).

Patients and Methods

50 patients with chronic renal failure on regular hemodialysis, 31 males and 19 females, with age ranging from 18 to 62 years, were included in the study. They were selected from those attending the nephrology and dialysis unit in Damanhour Medical Institute.

Dialysis sessions were done 3 times weekly, each session 4 hours on bicarbonate dialysate, with biocompatible membrane (polysulphone).

Ten age and sex matched subjects with normal renal functions (7 males and 3 females), aged from 22 to 63 years served as a control group; they were selected from those attending the sonography departement We excluded from the study patients with obesity, diabetes mellitus, liver disease, or other metabolic or endocrine disorders and those receiving drugs known to alter lipid or lipoprotein patterns such as duiretics, β-blocker were excluded.

Both the control and patients groups were subjected to the following :

1. Full history taking as regards the original disease of renal failure, ischemic symptoms (cerebral, coronary and peripheral).
2. Thorough clinical examination including CNS, CVS and peripheral vessels.
3. Standard resting electrocardiograms (ECG).
4. Lipid studies including LDL (14 hours fasting), total cholesterol and high density lipoproteins (non-fasting).

Blood samples were taken at the start of hemodialysis session. Total cholesterol was assayed enzymatically and HDL by precipitation method with dextran sulphate and magnesium chloride.

Non-fasting non-HDL from special equation :

Non-HDL = total cholesterol - HDL.

5. Duplex scanning of carotid and femoral arteries by general electronic volusion 750 using 7.5 MHz high resolution linear array transducer in the supine position with slight hyperextension of the neck.

Identification of carotid arteries was performed in both transverse and longitudinal sections by placing the transducer medial to the sternomastoid muscle. Optimal measurement of the intima-media thickness was obtained along the course of common carotid artery 2 cm proximal to the bulb after grey scale magnification to obtain detailed structure of the carotid wall. Identification of femoral arteries in the supine position, just under the middle of inguinal ligament.

Results

Aetiology of renal failure was as follows : glomerulonephritis in 14 patients out of 50(28%), hypertension in 17 patients out of 50 (34%), pyelonephritis in 5 patients out of 50 (10%), polycystic kidney in 2 patients out of 50(4%), analgesic nephropathy in 2 patients out of 50 (4%) and unknown in 10 patients (20%).

Table (1): Demographic data of the patients (n=50) and controls (n=10).

	Patients (n =50)	Control (n=10)
Sex : ¥ Male. ¥ Female	 31(62.0%) 19(38.0%)	 7(70.0%) 3(30.0%)
X2 P value	0.23 0.63 (non-significant)	
Age (in years): ¥ Range. ¥ Mean±SD	 18-62 40.4±11.88	 22-63 41.9±13.33
T P value	0.41 0.68 (non-significant)	

Table (2): Distribution of patients group (n=50) according to duration of dialysis.

	Frequency	
	No (out of 50)	%
< 12 months	7	14.0%
> 12-²36 months	18	36.0%
> 36-² 60 months	19	38.0%
More than 60 months	6	12.0
Range (months)	3-132	
Mean ±SD	38.28±24.63	

Table (3) : Comparative study as regards serum lipid profile between patients under regular hemodialysis and control group.

Lipid profile	Patients (n=50)	Control (n=10)	t, p value
Non fasting cholesterol (in mg/dl) Range Mean ±SD	 141-308 200.5±37.43	 150-200 169.1±16.81	 4.65 0.003* H.S.
Non fasting HDlL (in mg/dl) Range Mean±SD	 28-64 45.52±8.35	 35-66 48.8±10.01	 1.12 0.1757 N.S.
Non-fasting non-HDL (in mg/dl) Range Mean±SD	 91-280 151.2±39.68	 84.143 110±38.44	 4.21 0.0044* H.S
Fasting LDL (in mg/dl) Range. Mean±S.D	 62-174 107.52±26.07	 88-144 115.5±17.77	 1.03 0.1253 N.S.

Table (4): Comparaison between the patients group (n=50) and control group (n=10) regarding intima-media thickness (IMT) of both carotids and both femoral arteries thickness.

Lipid profile	Patients (n=50)	Control (n=10)	t, p value
IMT left carotid (in cm) Range Mean ±SD	 0.073-0.171 0.122±0.035	 0.065-0.110 0.0883±0.021	 3.21 0.01* H.S.
IMT right carotid (in cm) Range Mean±SD	 0.080-0.175 0.137±0.13	 0.052-0104 0.078±0.012	 2.85 0.031 S.
IMT left femoral (in cm) Range Mean±SD	 0.075-0.1777 0.126±0.034	 0.052-0.104 0.078±0.012	 2.85 0.026* S.
IMT of right femoral (in cm) Range. Mean±S.D	 0.075-0.166 0.122±0.022	 0.088-0.106 0.0987±0.01	 6.21 0.0001* H.S.

¥ IMT : intima-media thickness.

Table (5): Correlation between lipid profile and intima-media thickness (IMT) of both carotid and both femoral arteries in patients group.

Cholesterol		HDL	Non HDL	LDL
IMT of left carotid r P	 0.10 >0.05 N.S.	 0.01 >0.05 N.S.	 0.45 <0.05* S.	 0.40 <0.05* S.
IMT of right carotid r P	 0.29 >0.05 N.S	 0.29 >0.05 N.S.	 0.48 <0.05* S	 0.43 <0.05* S.
IMT of left femoral r P	 -0.23 >0.05 N.S.	 -0.11 >0.05 N.S.	 -0.35 <0.05* S.	 -0.34 <0.05* S.
IMT of right femoral r P	 -0.22 >0.05 N.S.	 -0.03 >0.05 N.S.	 -0.37 <0.05* S.	 -0.30 <0.05* S.

Table (6): Distribution of ECG ischaemic changes and carotid plaques in patients group (n=50).

	Frequency	
	No. out of 50	%
ECG ischaemic changes +ve -ve	 8 42	 16.0% 84.0%
Carotid plaques +ve -ve	 7 43	 14.0% 86.0%

Table (7):Comparaison between lipid profile and ECG findings in patients group (n=50), group 1.

ECG finding / Lipid profile (mg/dl)	Patients with -ve finding of ECG	Patients with +ve finding of ECG	t, P value
non fasting cholesterol (mg/dl) Range. Mean±SD	 141-290 190.33±41.62	 180-308 226.25±46.570	 2.45 0.018** H.S.
Non fasting HDL (mg/dl): Range. Mean±SD	 30-64 45.81±8.36	 28-54 44±8.668	 1.65 0.32 N.S.
Non fasting non HDL (mg/dl) Range . Mean±SD	 91-256 145.05±35.10	 143-280 183.5±48.858	 2.98 0.02* S.
Fasting LDL (mg/dl) Range. Mean±SD	 62-174 105.00±25.21	 85-174 120.75±28.238	 1.89 0.04* S,

Table (8): Comparaison between ECG findings and (IMT) of both carotids and both femoral arteries in patients group (n=50).

ECG finding / IMT (cm)	Patients with -ve finding of ECG	Patients with +ve finding of ECG	t, P value
IMT of left carotid Range. Mean±SD	 0.073-0.171 0.110±0.04	 0.099-0.162 0.135±0.022	 1.99 0.045* S.
IMT of right carotid Range. Mean±SD	 0.075-0.175 0.083±0.03	 0.085-0.177 0.136±0.022	 4.15 0.008** H.S
IMT of left femoral Range . Mean±SD	 0.07-0.171 0.091±0.009	 0.085-0.177 0.116±0.027	 3.82 0.009** H.S.
IMT of right femoral Range. Mean±SD	 0.075-0.166 0.112±0.02	 0.089-0.144 0.116±0.016	 1.05 0.187 N.S.

Table (9): Comparaison between lipid profile and carotid plaques in patients group (n =50).

Carotid plaques / Lipid profile (mg/dl)	Patients with -ve finding of carotid plaques	Patients with +ve finding of carotid plaques	t, P value
Cholesterol Range. Mean±SD	 141-308 200.36±50.93	 193-245 222.43±25.17	 2.34 0.032* S.
HDL Range. Mean±SD	 28-64 46.60±8.38	 33-62 44.71±9.32	 0.98 0.34 N.S.
Non HDL Range . Mean±SD	 91-280 142.26±42.54	 130-194 167.71±20.71	 2.65 0.01* S.
LDL Range. Mean±SD	 62-174 107.57±27.66	 83-125 103.71±14.40	 1.03 0.21 N.S.

Table (10): Comparaison between carotid plaques and IMT findings in patients group (n=50).

Carotid plaques / IMT (cm)	Patients with -ve finding of carotid plaques	Patients with +ve finding of carotid plaques	t, P value
IMT of left carotid Range. Mean±SD	 0.073-0.109 0.142±0.05	 0.073-0.171 0.101±0.032	 3.21 0.02* S.
IMT of right carotid Range. Mean±SD	 0.080-0.175 0.124±0.03	 0.083-0.160 0.110±0.02	 1.98 0.042* S.
IMT of left femoral Range . Mean±SD	 0.075-0.177 0.141 ± 0.041	 0.073-0.149 0.111±0.02	 1.99 0.041*S.
IMT of right femoral Range. Mean±SD	 0.075-0.166 0.112±0.02	 0.083-0.149 0.112±0.02	 0.98 0.41 N.S.

Table (11): Correlation between duration of dialysis and intima-media thickness (IMT) of both carotids and femoral arteries.

	Duration of dialysis	
	r	P
IMT of left carotid	0.398	0.012* S.
IMT of right carotid	0.42	0.003** H.S.
IMT of left femoral	0.61	0.0001 H.S.
IMT of right femoral	0.21	0.31 N.S.

Discussion

Cardiovascular disease is the major cause of death in ESRD patients (U.S. Renal Data System, 2003). Dialysis patie-nts have a cardiovascular mortality rate that is 10-20 times higher than the general population (Sarnak *et al*., 2000).

There are many reasons why CKD is associated with CVD. In cross sectional studies, individuals with CKD have more severe atherosclerosis(Shlipak *et al*., 2002).

A percentage of 30% of hemodialysis patients clinically have ischemic episodes with normal coronary angiograms (Rostand *et al*., 1984).

Hemodialysis patients with cardiova-scular disease exhibited higher levels of triglycerides (Koch *et al*., 1997), VLDL-cholesterol (Mahn *et al*., 1983), total cholesterol, LDL-cholesterol and lower levels of HDL-cholesterol and lower levels of HDL cholesterol (Koch *et al*., 1997) than those without cardiovascular disorders.

It has also been found that hemodialysis patients with a rapid increase in total amount of coronary artery calcifi-cation have higher triglyceride levels and lower HDL-cholesterol levels compared with patients who exhibit slow progress of coronary vessel lesions (Takashiro *et al*., 2001).

This study included fifty patients with chronic renal failure on regular hemodi-alysis 31 males and 19 females aged from 18 to 62 years with a (mean ±SD) age of (41.9±13.35) years served as control group.

Official recommendations in the general population employ LDL in fasting blood as gold standard lipid parameter in lipid related risk assessment. There are some problems in the use of fasting LDL-C among ESRD patients treated by hemodialysis. First, the use of only LDL-C ignores the atherogenic potentials of triglyceride-rich lipoproteins. The degree of association of IDL and VLDL with aortic sclerosis was greater than that of LDL in hemodialysis patients (Shoji *et al*., 1998). Second, it is difficult for many patients to obtain blood samples after overnight fasting for standard lipid analysis. Because plasma triglyceride level is greatly affected by eating, the friedural formula, gives falsely lower LDL-C if non-fasting specimens are used. More recent, National cholesterol education program adult treatment panel III (NCEP ATP-III), Executive summary of the third report of the National Cholesterol Education Program (NCEP, 2001), listed non-HDL-C, as well as LDL-C, as target lipid parameters in subject with hypertriglyceridemia.

Non-HDL-C is the sum of LDL-C and choleserol in triglyceride rich lipoproteins, but can be easily calculated by subtracting HDL-C from total cholesterol. Because HDL-C is hardly affected by eating, (Wilder *et al*. 1995), non HDL-C may be a better index than LDL-C for routine practice in most of hemodialysis patients. Non fasting non-HDL-C can be easily calculated from total cholesterol and HDL-C without limitation in hypertriglyceridemia.

In this study, (table 3), the serum level of cholesterol and non-fasting non-HDL were significantly elevated in hemodialysis patients compared to control group (P = 0.003 and P=0.044), respectively. This goes with (Attman *et al*., 1991), who found that dialysis patients with vascular disease have increases in serum triglycerides, total cholesterol and VLDL cholesterol with lower levels of HDL-cholesterol.

Non-fasting non-HDL-C is a marker that integrates atherogenic potentials carried by VLDL, IDL and LDL. In the study of Shoji *et al*. (1998), although IDL was the lipoprotein that was most closely associated with aortic sclerosis, VLDL and LDL were also significantly associated with aortic sclerosis independent of other non-lipid variables. Therefore, use of only one lipoprotein level may miss the significant contribution of other lipoproteins . Nishizawa *et al*. (2003) has evaluated the power of non-fasting non-HDL-C in predialysis serum as a predictor of cardiovascular mortality in a cohort of 525 hemodialysis patients. During the mean follow-up of 64 months, 120 deaths, including 44 fatal cardiovascular events, occurred. Patients in the highest tertile of non-fasting non-HDL-C (137 to 285 mg/dl) had a significantly higher risk for cardiovascular mortality.

They concluded that non-fasting non-HDL in predialysis serum was a significant and independant predictor of cardiovascular mortality in hemodialysis patients.

The early stages of atherosclerosis are associated with changes in arterial structure. Subtle structural changes such as thickening of IMT occur early in the atherosclerotic disease process (Bernadette *et al*., 2001; Kato *et al*., 2003 and Papagiani *et al*., 2003). Ultrasonic evaluation of carotid artery for IMT of carotid and femoral arteries (superficial vascular districts) can identify patients at risk for cardiovascular disease.

In this study, (table 4), IMT of both carotids and both femoral arteries were elevated in hemodialysis patients as compared to control group. This goes with most studies that found a significant increase in IMT in the carotid arteries of HD patients compared with healthy control subjects (Kawagishi *et al*., 1995; London *et al*., 1996 and Mojs *et al*., 2000).

Benedetto *et al*. (2001) found that IMT may be usefully applied for risk stratification in the dialysis population. Damjavonic *et al*. (2003) evaluated IMT of 45 dialysis patients and found higher mean carotid IMT in HD patients than in control group Kagaguishi *et al*. (1995), showed that IMT was significantly higher in HD patients than in age and gender matched control subjects.

In this study, there was no significant correlation between level of non-fasting serum cholesterol, non-fasting HDL and IMT of both carotids and both femoral arteries (table 5), while there was a significant positive correlation between non-fasting non-HDL and IMT of both carotids and both femoral arteries. Also, there was a significant positive correlation between fasting LDL and IMT of both carotids and both femoral arteries ($P<0.05$).

This goes with most results of Kawagishi *et al*. (1995); London *et al*., 1996), that failed to find a relationship between IMT and serum cholesterol and triglycerides in dialysis patients, probably because the relationship of serum cholesterol to mortality is U-shaped (Lowrie *et al*., 1990). Increased mortality risk at low serum cholesterol levels most likely reflects confounding malnutrition in these patients. Sarnak *et al*. (2000) and Burdick *et al*. (1994) found a correlation between IMT and fasting LDL cholesterol in dialysis patients.

In this study, 16% (8 out of 50) of the patients group had cardiac ECG ischemic changes, while 14% (7 out of 50) had plaques in the carotid artery wall (table 6). This goes with (Pacazice *et al*., 1996; Savage *et al*. (1998).and Mojs *et al*., 2000). who found that there is a significant increase in plaque occurrence in hemodialysis patients.

In this study, there was a significant positive correlation between non-fasting serum cholesterol, non-fasting non-HDL and fasting LDL and cardiac ECG ischemic changes, (table 7) (P = 0.018, P = 0.02, P = 0.04) respectively. Also there was a significant positive correlation between non-fasting serum cholesterol, non-fasting non-HDL and carotid plaques, (table 9), (P = 0.032, P = 0.01), respectively. There was no significant correlation between non-fasting HDL, fasting LDL and carotid plaques.

Pascazio *et al*. (1996) observed a large number of vascular plaques in uremic patients. They concluded that the process of advanced atherosclerosis might be started with the beginning of renal failure, they suggested that hemodialysis treatment may not be a potential factor to accelerate atherosclerosis. Finally, they concluded that the progression of atherosclerosis might be related to atherogenic factors operative before regular dialysis.

Mojs *et al*. (2000). Also in their study 28 HD patients found that, age was the only significant determinant of the number of plaques. He concluded that hemdialysis patients had advanced atherosclerosis in the carotid arteries compared with normal subjects.

Previous Cross-Sectional

Studies showed that in ESRD patients.
(non-HDL-C) was an independent factor associated with carotid artery intima-media thickness (Shoji *et al*., 2000) and aortic sclerosis (Shoji *et al*., 1998 and Shoji *et al*., 2001).

In this study, there was a significant positive correlation between the duration of dialysis and IMT of both carotids and left femoral arteries, while there was no significant correlation between the duration of dialysis and IMT of right femoral artery. This goes with Burdick *et al*. (1994), who found a positive significant relation between carotid intima-media thickness and dialysis duration.

In contrast, correlation of IMT with ages and duration of hemodialysis in HD patients was evaluated, by Shoji and by Mojs. No clear relationship of IMT with duration of hemodialysis treatment was found in their studies (Mojs *et al*., 2000 ; Shoji *et al*., 2002).

In previous studies, the IMT of carotid arteries was not associated with HD duration, thus suggesting that the atherosclerosis may be accelerated by the uremic state per se rather than by the hemodialysis (Rawagishi et al., 1995; London *et al*., 1996 ; Mojs *et al*., 2000).

In our study, there was a positive correlation between cardiac ECG ischemic changes and IMT of both carotids and left femoral arteries, while there was no significant correlation between cardiac ECG ischemic changes and IMT of right femoral artery (table 8).

In this study, there was a significant positive correlation between carotid plaques and IMT of both carotids and left femoral arteries, ($P<0.05$, table 10), while there was no significant correlation between carotid plaques and IMT of right femoral artery (table 10).

These findings are in accordance with the study of Mojs *et al*. (2000), that involved 102 non-diabetic patients, B-mode ultrasonography was used to compare IMT and plaque occurrnce in the carotid arteries of these patients with those of 30 control subjects without renal failure. The IMT was higher in the HD patients (0.75 mm versus 0.62 mm), more patients had plaques (64% versus 23%) than in the control group and the number of plaques in the patients was greater.

Mojs *et al*. (2000) found that IMT values also correlated with total and LDL cholesterol. Plaque occurrnce correlated with age, total and LDL cholesterol, triglycerides and smoking the number of plaques correlated with age and with total and LDL cholesterol.

Non fasting non-HDL-C (total cholesterol minus HDL) is an additional target and should be less than 130 mg/dl, if triglyceride levels are greater than or equal to 200. Non-HDL cholesterol has the additional benefit that it can be measured using non-fasting blood specimens (NKF guidelines, 2003 and Nishizawa *et al*., 2003) found that non-fasting non-HDL-C predicts future cardiovascular mortality in a cohort of hemodialysis patients.

In our study, level of non-HDL more than 130 mg/dl was observed in more than 65% f patients group versus 30% in control group. Also, there was positive correlation between nonfasting non-HDL and IMT of both carotids and both femoral arteries in patients group, therefore non-fasting non-HDL with a cut off 130 mg/dl is a good predictor of atherosclerosis in hemodialysis patients (table 5).

Conclusion

In our study, we found that non-fasting non-HDL was as relevant as fasting LDL in predictiron of occurrnce of cardiovascular complications in HD patients, but it has the advantage that it can be measured non-fasting.

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البروتينات الدهنية غير عالية الكثافة فى المرضي غير الصائمين كمؤشر لأمراض القلب وتصلب الشرايين فى مرضي الفشل الكلوي المزمن المعالجين بالإستصفاء الدموي

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أستهدف هذا البحث الدراسة والمقارنة بين الدهون غير عالية الكثافة فى المرضي غير الصائمين والدهون منخفضة الكثافة فى المرضي الصائمين كمؤشر لتصلب الشرايين فى مرضي الفشل الكلوي المزمن المعالجون بالإستصفاء الدموي المتكرر.

وقد شملت الدراسة خمسون مريضاً بالفشل الكلوي المزمن والمعالوجون بالإستصفاء الدموي المتكرر (31 رجل، 19 إمراة) يتراوح أعمارهم ما بين 18 : 62 سنة بمتوسط عمر 40.4 ± 12 سنة وعشرة من الأصحاء (7 رجال و3 نساء) كحالات متابعة تتراوح أعمارهم ما بين 22 :32 سنة بمتوسط عمر 41.9 ± 13.35 سنة.

وقد تم تقسيم المرضي حسب سبب الفشل الكلوي إلى : مرضي التهاب حبيبات الكلي (14 مريض)، مرضي ضغط الدم المرتفع (17 مريض)، مرضي الإلتهاب الصديدي للكلي (5 مرضي)، مرضي الكلي العديدة الحويصلات (2 مريض)، مرضي التهاب الكلي الناتج عن المسكنات (2 مريض)، مرضي غير معروف سبب الفشل الكلوي لديهم (10 مرضي).

كما تراوحت مدة العلاج بالإستصفاء الدموي ما بين مدد أقل من سنة إلى مدد أكثر من 5 سنوات.

وقد تم عمل الأتي لجميع المرضي والأصحاء :

أخذ تاريخ مرضي كامل لهم، فحص إكلينيكي شامل لهم، رسم قلب عادي، ودوبلكس على الشريان السباتى الأيمن والأيسر وكذلك على الشريان الفخذي الأيمن والأيسر، تحاليل كيميائية وتشمل : الكولسترول والدهون عالية الكثافة فى المرضي غير الصائمين والدهون منخفضة الكثافة فى المرضي الصائمين.

وكانت نتائج البحث كالأتي :

- إرتفاع مستوي الدهون غير عالية الكثافة فى المرضي غير الصائمين.
- سمك الطبقة الداخلية حتي الطبقة الوسطي كان أعلي بدرجة ملحوظة فى مرضي الإستصفاء الدموي مقارنة بالأصحاء من نفس العمر والجنس.
- كان هناك علاقة بين سمك الطبقة الداخلية حتي الطبقة الوسطي بالشريان الثباتي ومدة الإستصفاء الدموي.
- لم يكن هناك علاقة بين سمك الطبقة الداخلية حتي سمك الطبقة الوسطي من الشريان الثباتي والشريان الفخذي ومستوي الدهون عالية الكثافة والكولسترول فى المرضي غير الصائمين.
- في حين كان هناك علاقة تبين سمك الطبقة الداخلية حتي سمك الطبقة الوسطي ومستوي الدهون غير العالية الكثافة فى المرضي غير الصائمين والدهون منخفضة الكثافة فى المرضي الصائمين.
- 16% من المرضي وجدوا أنهم يعانون من قصور وضيق الشريان التاجي وفى هؤلاء المرضي وجد علاقة بين سمك الطبقة الداخلية حتي الطبقة الوسطي من الشريان السباتى

الأيمن والأيسر والشريان الفخذي الأيسر فى حين لم يكن هناك علاقة بين سمك الطبقة الداخلية حتي سمك الطبقة المتوسطة من الشريان الفخذي الايمن.

- كان هناك علاقة بين مدة الغسيل الدموي وسمك الطبقة الداخلية حتي الطبقة الوسطي من الشريان الثباتي الأيمن والأيسر والشريان الفخذي الأيسر في حين لم تكن هناك علاقة بين سمك الطبقة الداخلية حتي الطبقة الوسطي من الشريان الفخذي الأيمن ومدة الغسيل الكلوي.